

Evaluating Plant Available Water in Biochar-Amended Soils—A Preliminary Study Towards Enhancing Lunar and Martian Regolith for Plant Growth

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Outline

- Waste management
- Plants
- Regolith
 - Earth
 - Moon
 - Mars
- What has been done
- What's being done
- How this can be used in space

Waste Management



Biomass Feedstocks

- Pecan
 - Shells
 - Orchard Prunings
- Cotton Gin Trash
- Yard Waste



<http://learningtoheal-walk2write.blogspot.com/2012/05/happy-ending-for-pecan-shells-in-my.html>

<http://aces.nmsu.edu/pubs/research/horticulture/rr-764/welcome.html>

<http://agresearchmag.ars.usda.gov/2008/nov/cotton/>

<http://www.wdm.iowa.gov/residents/solid-waste-yard-waste-recycling/yard-waste>

Shuttle Waste

- A crew of four makes ~2,500 kg of solid waste in one year



Guys Shirt: Template



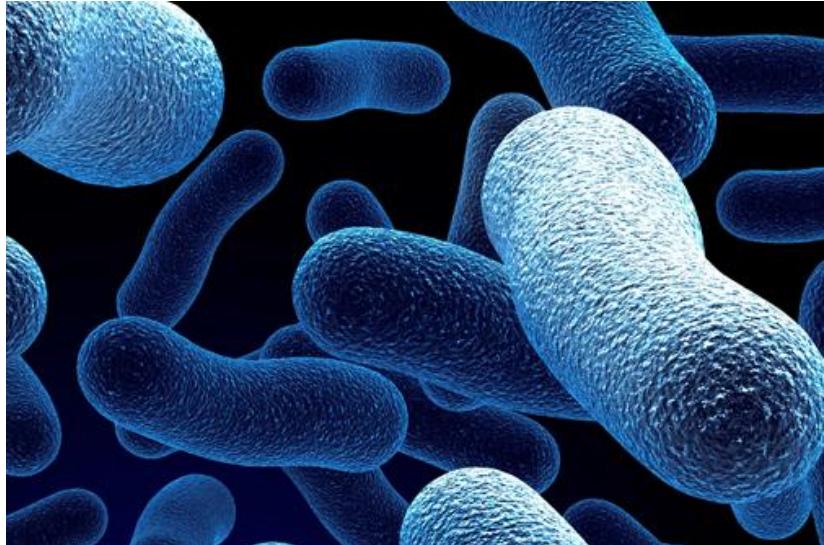
Plants



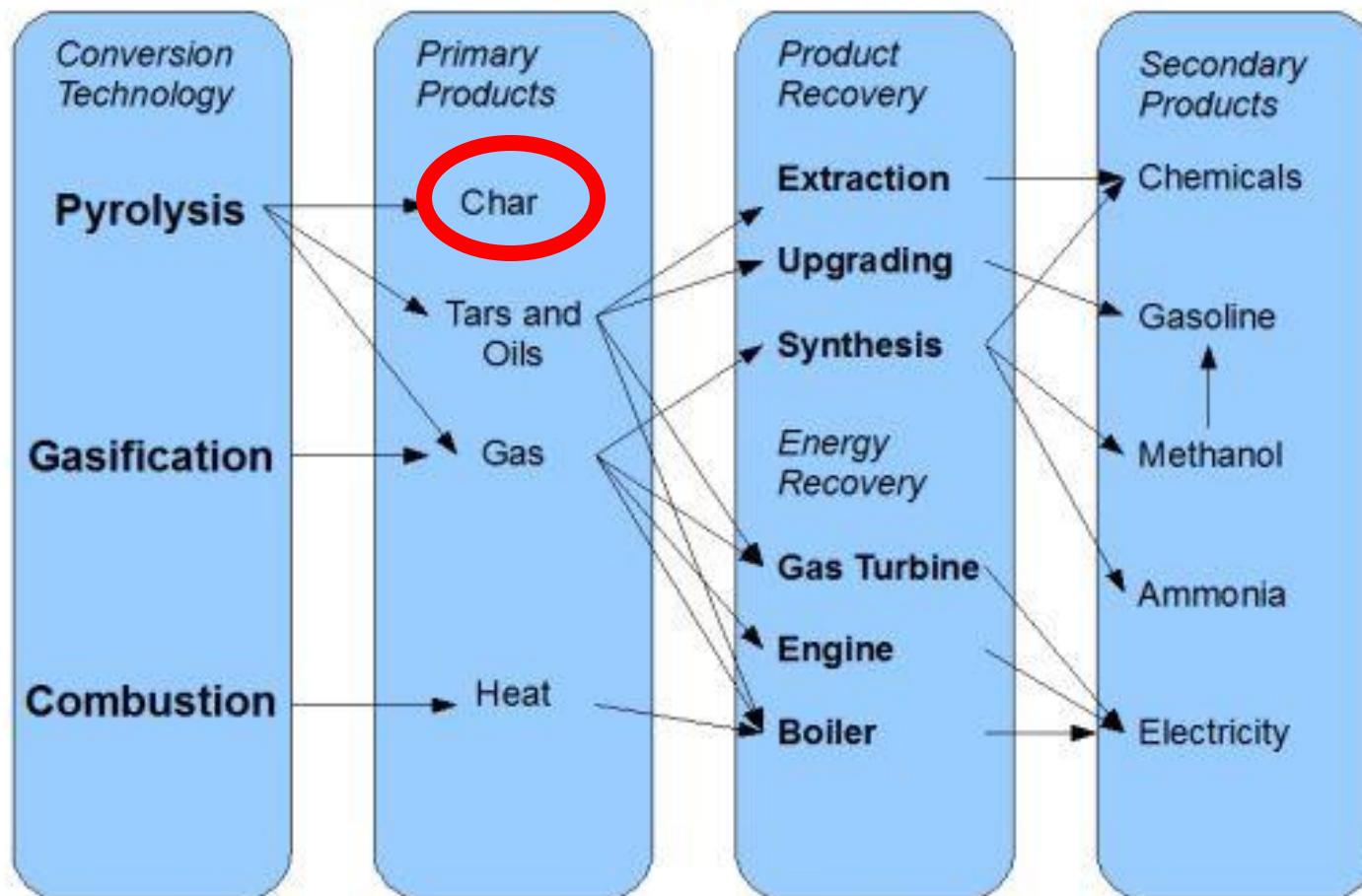
Air



Nutrients



Thermal conversion processes and products



Ref: Bridgwater, A.V., 1994a. Catalysis in thermal biomass conversion. Applied Catalysis A: General 116, 5-47.
Gasification information from <http://gasification4energy.com>

Methods of Pyrolysis

Mode	Conditions	Bio-oil	Biochar	Gas
Fast	Moderate temperature (500°C) for 1s	75%	12%	13%
Intermediate	Moderate temperature (500°C) for 10-20s	50%	20%	30%
Slow	Low temperature (400°C) with very long solids residence time	30%	35%	35%
Gasification	High temperature (800°C) with long vapor residence time	5%	10%	85%



Types of soils

Sandy Loam

- Drains quickly
- Larger particles



Clay Loam

- Small Particles
- Good absorption
- Drainage problems
- Bad aeration

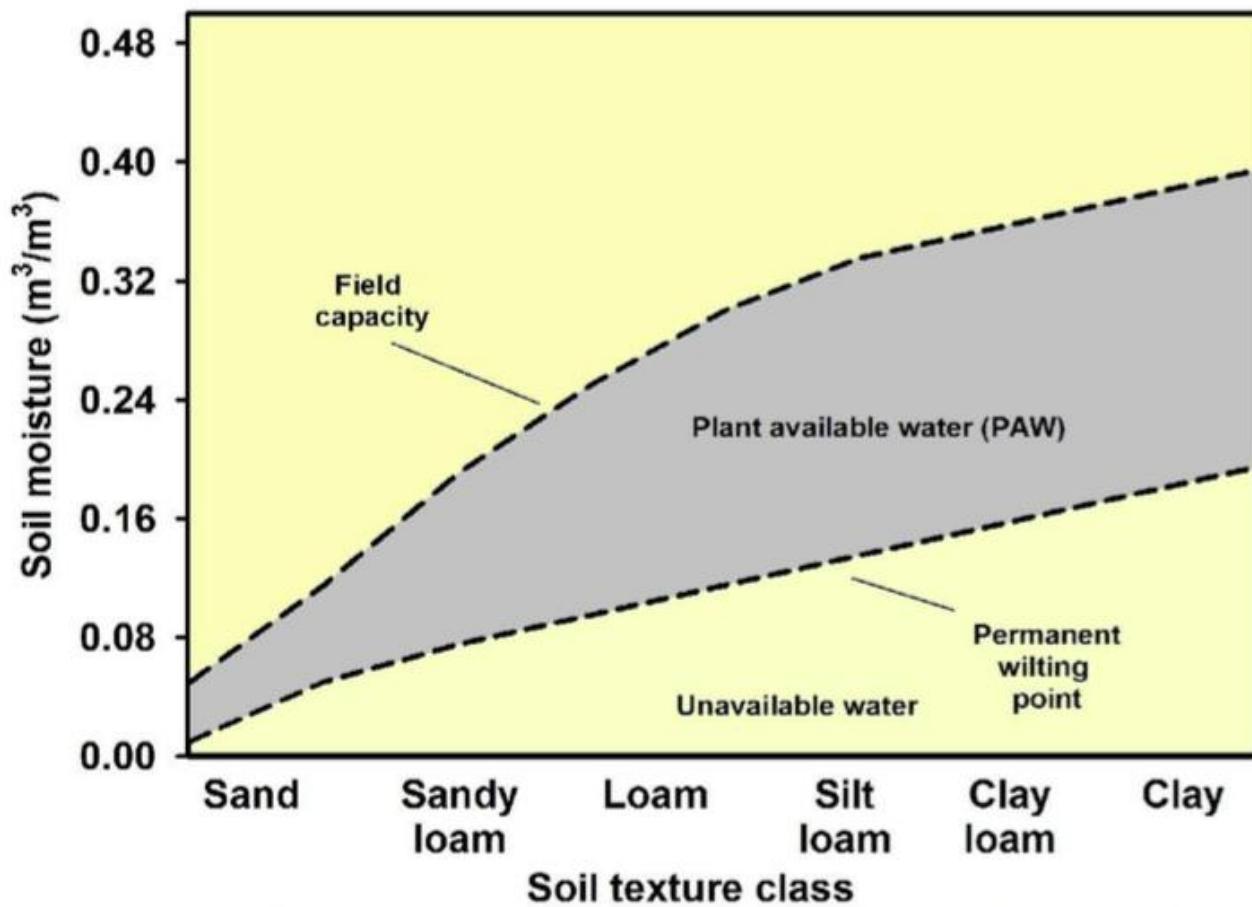


Fig. 1. General relationship between plant available water (PAW), field capacity, permanent wilting point and soil unavailable water and soil texture class.

HYPROP Tensiometer and WP4C Dewpoint Potentiometer



<http://www.decagon.com/education/water-potential/measuring-water-potential/laboratory-instruments-for-measuring-water-potential/precision-tensiometer-water-potential-and-hydraulic-conductivity-function>

http://www.ums-muc.de/en/products/soil_laboratory/hyprop.html

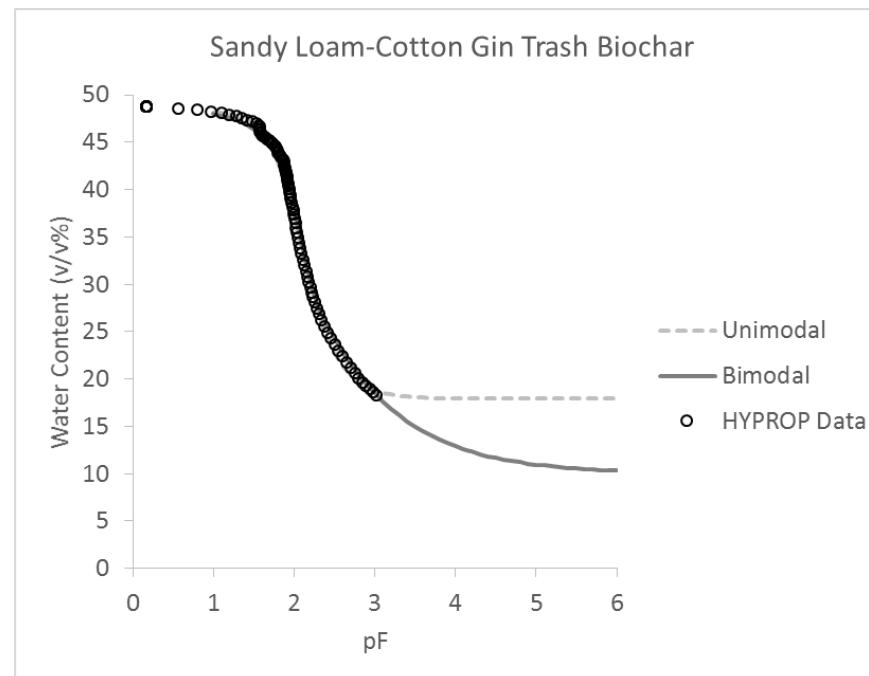
<http://es.ddi.quinn.com/productos/modelos-discontinuados/wp4-dewpoint-potentiometer/>

Unimodal van Genuchten/Mualem model (van Genuchten, 1980)

$$\frac{\theta - \theta_r}{\theta_s - \theta_r} = \frac{1}{[1 + (\alpha|h|)^n]^{(1-1/n)}}$$

Where:

- θ is the volumetric water content
- h is the soil water tension or “height”
- Θ_s , θ_r , α and n are model parameters

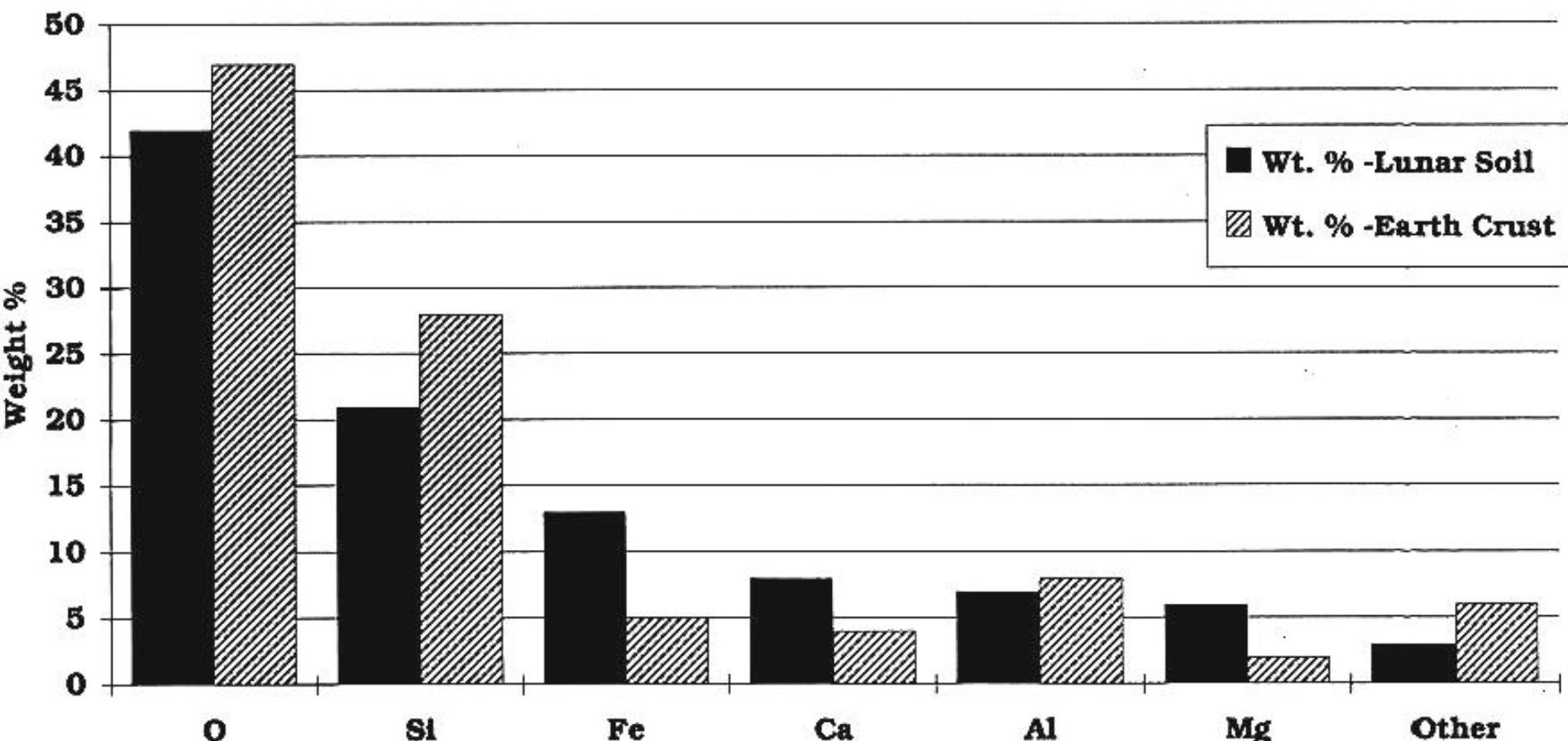


Regolith

- Earth
- Lunar
- Martian



The Surface of the Moon is Slightly Richer in Fe, Ca, and Mg Compared to the Earth's Crust



Lunar Regolith Simulant

Basaltic volcanic
cinder cone deposits
from a quarry near
Flagstaff, AZ



Martian Regolith

- Ferrous minerals, oxides, sulfides
 - Reddish color
- Pyroxene, basalt, Ca-sulfates



Martian Regolith Simulant

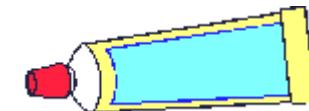
Samples collected from the Pu'u Nene cinder cone located in the saddle between Mauna Loa and Mauna Kea volcanoes on the island of Hawaii.



Research Done

- Made Biochar from local waste
- Amended local soils with biochars
- Measured soil water potential of amended soils

Future Research: Make biochar out of “local” waste



Guys Shirt: Template

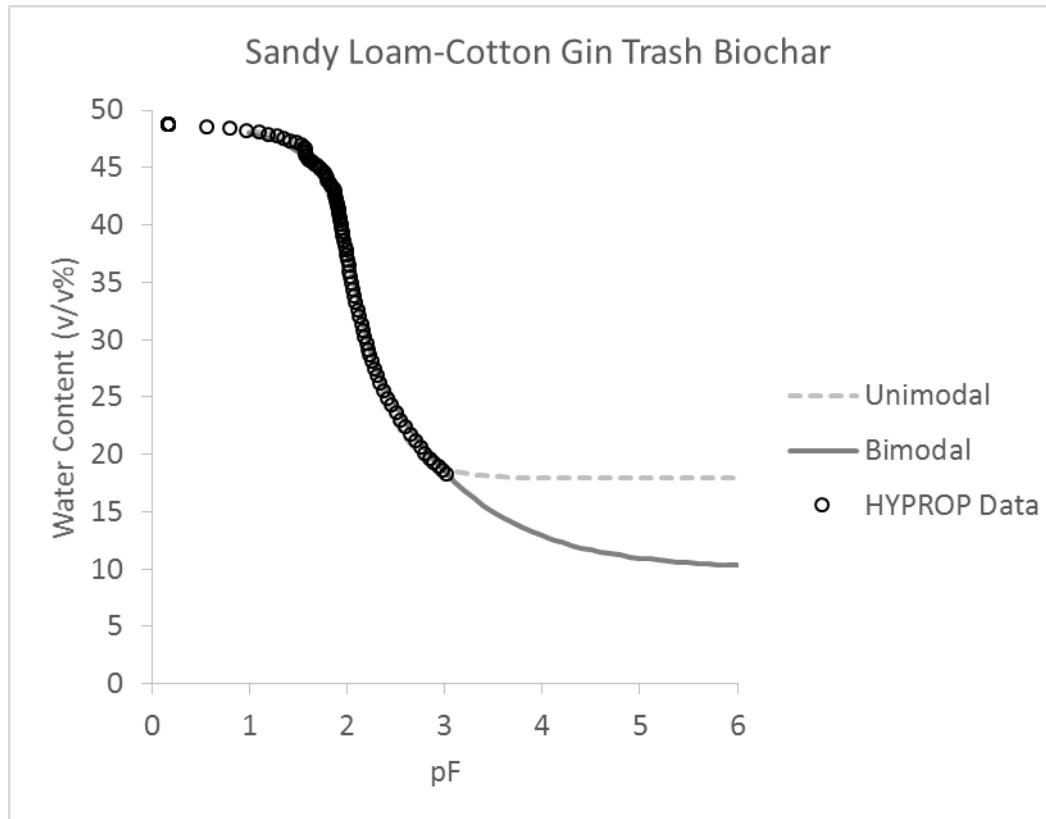


Future Research: Amend “local” soils



http://meteorites.wustl.edu/lunar/regolith_breccia.htm
http://www.rutgersprep.org/kendall/7thgrade/cycleA_2012-13/05_SC/Can-Mars-resource-support-life3.html
<http://arpinfo.com/rotationalCrops.html>

Future Research: Measure soil water potential

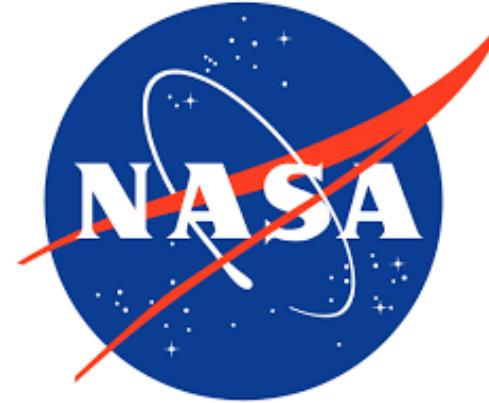


Conclusion

- Soils here and there need help to grow plants
- Plant available water (PAW) is affected by amendments.
- Biochars have potential for improved PAW

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Reference

Brewer, Catherine E., and Idowu, O. John.
Design of Biomass Pyrolyzer-Desalination Unit Interface for Distributed Biochar and Clean Water Production. Rep. N.p.: n.p., n.d. Print.

Information and Questions

Poster

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